REMARKS

The subject specification is directed to improvements in optically pumped semiconductor (OPS) lasers. In particular, the lengthy specification includes a fairly detailed discussion of the results of inventors' engineering efforts to scale up an OPS laser from a low output power scientific experiment to a commercially viable product. For example, the specification describes particular resonator and pump configurations, mode control and thermal management concepts which yielded lasers that could generate output powers many times higher than what was currently being reported in the literature.

In the Office Action, the Examiner rejected claims which included certain high output power limitations by arguing that it is a matter of "operational design choice to achieve high output powers." This reasoning demonstrates a failure by the Examiner to appreciate the difficulties in improving the performance of a laser system. Those skilled in the art understand that efforts to increase the power of laser, or laser scaling, can be one of the most difficult of all engineering problems. If this were not the case, bulky and expensive gas lasers (e.g. ion lasers and excimer lasers) would long ago have been replaced by solid state lasers. While it is no doubt true that it would be obvious for one skilled in the art to <u>desire</u> to operate at higher powers, it is quite another matter to argue that it would be obvious to obtain such higher output powers simply because the desire is present.

After reviewing the Office Action, Applicants have deleted a number of claims in order to simplify the issues. In particular, Applicants have cancelled claims 61 to 68 and 77 to 86 which primarily related to particular resonator geometries. Applicants reserve the right to prosecute these claims in a continuation case.

The claims remaining in the application fall into three groups - those requiring a fundamental output power of at least 2 watts, those requiring a frequency doubled output power of at least 100 milliwatts and claims 53 to 58 which specify a gain medium where the active layers have a composition which includes $In_x Ga_{1-x} N$ (InGaN). Each of these claim groups will be discussed separately.

Turning first to claims 53 to 58, in the previous Office Action, Applicants noted that the prior art Alford patent failed to disclose an OPS laser where the active layers included InGaN material. On page 3 of the current Office Action, the Examiner commented that this argument was persuasive and withdrew the rejection and stated that he was entering a new ground of

rejection in view of newly found prior art. The text of the rejection of claim 53 appears beginning on page 8 of the Office Action. Here, the Examiner again relies on Alford and simply states that it would be obvious to use known materials in the laser of Alford. The Examiner does not cite any "new prior art" nor does the Examiner establish that InGaN a was known laser material. Of course, Applicants have not suggested that it invented an InGaN composition. InGaN is a well known composition used in laser diodes emitting blue light. Rather, Applicants believe it is inventive to use this particular material as part of the gain structure in an OPS laser. It should be noted that materials suitable for use in laser diodes are not necessarily suitable for use in an OPS laser and the Examiner has done nothing to demonstrate that one skilled in the art would consider a composition of InGaN to be suitable as the active layer material in an OPS laser. For these reasons, the rejection of claims 53 to 58 must be withdrawn.

Independent claims 59 and 70 include the limitation that the fundamental output power of the OPS laser is greater than 2 Watts. Claim 59 was rejected based on the article by Rosiewicz. The article by Rosiewicz is a general background article appearing in a trade magazine rather than a technical journal. As such, it discusses the general principles of an OPS laser and their general differences compared with other laser systems. The article states that the authors have "demonstrated" an output power of 600mw in a OPS laser. The article contains no specific discussion of how such a laser was built to achieve this level of output power. One skilled in the art referring to this article would be hard pressed to build an OPS laser that generated 600mw much less a laser having an output power more that three times higher (2 Watts). As noted above, there is no doubt that one skilled in the art would have the desire to build a laser system that generated higher output powers, however desire is not the test of obviousness. Rather, the prior art reference must provide a teaching from which one skilled in the art would find it obvious to achieve the claimed subject matter. Rosiewicz simply fails to provide any such teaching and the rejection of claim 59 should be withdrawn.

In the Office Action, claim 70 was rejected based on the Alford article. This rejection is even more strained. Alford relates to a frequency doubled laser having a maximum output power of only 5 milliwatts. Since Alford's laser is configured for frequency doubling, there is very little output power at the fundamental wavelength (only about 1 milliwatt). One skilled in the art would not find obvious the subject matter of claim 70, which defines a method for treating material with greater than 2 Watts of fundamental output power from an OPS laser, based on the

Alford article which merely teaches a frequency doubled laser generating only 1 milliwatt of fundamental output power. Accordingly, this rejection should also be withdrawn.

Independent claims 45 and 73 include the limitation that the frequency doubled output power of the OPS laser is greater than 200 milliwatts. As in the first Office Action, claim 45 was rejected as being obvious over a combination of Rosiewicz and Alford. In Applicants' previous response, it was noted that Alford teaches a frequency doubled output of only 5 milliwatts while Rosiewicz only teaches a fundamental output power of 600 milliwatts. On page 2 of the Office Action, the Examiner supported his continued rejection because, in his opinion, adding a doubling crystal into Rosiewicz would not drop his output power. However, as previously noted by the Applicants, adding a frequency doubling crystal to a resonator will, in fact, reduce output power and the examiner's opinion to the contrary, asserted without any scientific support, is simply incorrect.

There are many reasons why Rosiewicz would not be able to generate 600mw of frequency doubled light if a doubling crystal were added to his resonator. First, a doubling crystal has faces and faces create losses. Second, additional, more sophisticated optical coatings must be provided to maintain the circulation of the fundamental beam while outcoupling the second harmonic light. More complex coatings result in higher losses. Third, one cannot simply "add" a crystal to a resonator. Rather careful consideration must be given to account for proper phase matching of the crystal which includes angle tuning, temperature control as well as proper wavelength selection. Still further and perhaps most importantly, frequency doubling is a non-linear operation that scales quadratically with circulating power. Thus, at lower powers, it is dramatically more difficult to obtain a decent level of frequency doubled output power. Some evidence of this drop off can be seen in the Alford paper in which he is only able to achieve a 1.5% pump to blue (doubled light) conversion efficiency when operating with a 333 milliwatt pump. As noted above, Rosiewicz is a general article and does not provide any details of the laser construction or pump powers so actually predicting what might happen if a frequency doubler was "added" to the laser is simply not possible. It is respectfully submitted that it is improper for the Examiner to rely on the recitation of the fundamental output power of Rosiewicz to somehow establish a benchmark for the expected output power of a frequency doubled laser. The real comparison should be to Alford who designed his laser to generate

frequency doubled light and was only able to achieve an output of 5 milliwatts. For this reason, it is believed that claim 45 defines patentable subject matter.

Claim 73 was rejected as being obvious based on Alford in view of Mooradian and Kuznetsov. Mooradian was cited for his comment that his laser might be scalable upwardly to generate greater than 100 Watts average power. As noted in the Applicants' previous response, Mooradian's comment is simply a statement of what ***might*** be achieved if such a system was ever built and scaled up. In fact, the Mooradian patent includes no experimental data whatsoever and there is no indication that the relatively complex devices described therein were ever built. Moreover, Mooradian's comment relates only to the fundamental wavelength output and has nothing to do with a frequency doubled laser. Kuznetsov was only cited for its teaching of a plurality of transverse modes. In view of the above, it is submitted that none of the prior art, whether taken alone or in combination, renders obvious the subject matter of claim 73.

Dependent claim 74 specifies that the frequency doubled output power is greater than 5 Watts. Five Watts of frequency doubled output power is 1000 times greater than the 5 milliwatt frequency doubled output reported by Alford. It is also 30 times greater than the fundamental output power reported in Rosiewicz. Surely, even with the Examiner's improper reliance on Rosiewicz, claim 74 must define patentable subject matter. Applicants have added new claim 88 which depends on claim 45 and is similar in scope to claim 74. Applicants have also added new claims 87 and 89 which specify a frequency doubled output of 1 Watt. Support for this limitation can be found in the specification at page 65, line 11. This output power is two hundred times greater than that reported by Alford. It is respectfully submitted that these claims of intermediate scope are also patentable.

In the Office Action, the Examiner rejected the dependent claims on various combinations of the prior art. It is believed that each of these secondary references was addressed in the Applicants' prior response and need not be repeated here.

In view of the above, it is respectfully submitted that each of the pending independent claims defines patentable subject matter and allowance thereof, along with the claims depending therefrom, is respectfully solicited.

Respectfully submitted,

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